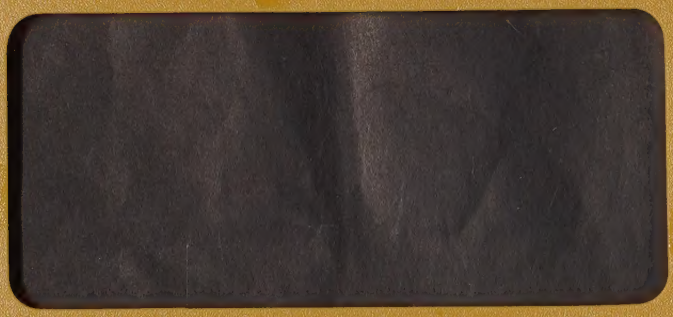
MODEL 501

LOGARITHMIC LEVEL METER

INSTRUCTION MANUAL

WILTRON



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WARRANTY

All products are warranted against defects in materials and workmanship for one year from the date of shipment except sweep generator oscillators, which have a two-year warranty period. Our obligation covers repairing or replacing products which prove to be defective during the warranty period and which shall be returned with transportation charges prepaid to WILTRON. Obligation is limited to the original purchaser. We are not liable for consequential damages.

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SECTION I

GENERAL INFORMATION

1-1. DESCRIPTION

The WILTRON Model 501 Logarithmic Level Meter measures changes in RF power levels applied to an external r.f. detector over the level range from -40dBm to +20dBm. The readout is in linear dB, on either the built-in panel meter for CW measurements or on an external oscilloscope for swept frequency measurements. The instrument is self-contained, including a power supply for 115/230V, 50-400Hz operation. It is 5-1/4" high, 11-1/2" wide, and 11-1/2" deep.

1-2. APPLICATION

The instrument is particularly useful for measuring return loss, VSWR and filter or amplifier transmission characteristics. Readout is linear in dB's and in addition, a calibrated dB offset control is provided which eliminates any meter scale or oscilloscope linearity error. The display sensitivity is switch selectable from 0.5 to 10dB per cm on oscilloscope displays and per division on the internal meter.

1-3. FEATURES

Features which make the Model 501 particularly versatile for making accurate RF measurements include:

1. Direct readout on a linear dB scale.
2. Easy compensation of a wide range of detectors for operating to levels as high as +20dBm.
3. Normal operation to below -40dBm with most RF detectors. Greater sensitivity can be obtained by connecting an RF amplifier ahead of the r.f. detector.
4. OFFSET DB Polarity Switch permits gain or loss measurements.

SECTION II

SPECIFICATIONS

FREQUENCY RANGE:	Limited only by the r.f. detector and connectors used.
DYNAMIC RANGE:	-40 to +20dBm applied to external r.f. detector.
ACCURACY:	±0.3dB ±1% of dB readout using the Offset control. When meter readout is used, the additional meter error is ±1% of full scale.
OFFSET:	Calibrated over more than ±90dB range.
DISPLAYED SENSITIVITIES:	10, 5, 2, 1 or 0.5dB per major meter division.
VIDEO OUTPUT:	5K ohms or less source impedance. Using an oscilloscope with 1 volt per cm vertical sensitivity, the display becomes 0.5, 1, 2, 5 or 10dB per cm.

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SECTION III

OPERATION

3-1. CONTROL OR INDICATOR	FUNCTION
POWER:	Pushbutton type red switch is illuminated when the power is on.
LOSS OFFSET dB:	Calibrated control offsets the output signal enabling precision measurements using a slide-back technique. Positive or negative offsets may be applied for direct reading gain or loss measurements.
FILTER IN/OUT:	Noise filter smooths output signal when working with low level inputs.
VIDEO OUTPUT:	Furnishes a 1 volt per major meter division output for swept frequency measurements for use with an oscilloscope set to 1 volt per cm vertical sensitivity.
ZERO dB SET:	Uncalibrated control offsets output signal to enable arbitrary setting of the reference level from which calibrated measurements are made using LOSS OFFSET dB control.
PANEL METER ON/OFF:	This switch allows the operator to disable the panel meter if desired when using an oscilloscope for swept frequency displays.
OUT OF RANGE:	The out of range light is illuminated at input levels corresponding to detector power levels of less than -45dBm or more than +20dBm informing the operator that accuracy will be impaired. The absolute power levels at which the indicator is activated will vary a few dB from those stated depending on the sensitivity of the detector used.
INPUT FROM DETECTOR:	The dc output from the external detector is connected here.
DETECTOR TRACKING ADJUST:	The HIGH LEVEL tracking adjustment is made with inputs of +5 to +20dBm applied to the external detector. The LOW LEVEL tracking adjustment allows adjustment of the input amplifier balance to compensate for dc offsets which may occur due to ground currents.

SECTION III

OPERATION Cont.

SENSITIVITY dB PER DIVISION:	Permits selection of meter and video output sensitivity from 0.5 to 10dB per major division.
BLANKING INPUT:	Back panel input accepts blanking signal from sweep oscillator (select positive or negative as needed with the particular sweep oscillator) for the purpose of displaying a reference line during RF retrace when using an oscilloscope for readout. Not used for CW measurements with meter readout.
MARKER INPUT:	This back panel input will accept video markers from the sweep generator markers to the oscilloscope display.

3-2. DETECTOR TRACKING ADJUSTMENT PROCEDURE

Whenever it is necessary to change the RF detector, a simple recalibration must be performed using the front panel DETECTOR TRACKING ADJUSTMENTS. These adjustments compensate for the detector's departure from square law response at high input power levels and for small ground currents and amplifier input offsets at low levels. When the ambient temperature environment of the detector fluctuates, the tracking should be periodically checked since the detector's departure from square law response is temperature dependent.

NOTE: The best tracking accuracy and sensitivity will be obtained using sensitive detectors having a video impedance of less than 20k ohms.

The tracking adjustment procedure is as follows:

a. Furnish a +10dBm ±5dB CW RF signal at a convenient test frequency (20 - 100 MHz) through a precision attenuator (0dB, -40dB, -50dB as required below) to the r.f. detector being calibrated.

b. Connect detector output to "INPUT FROM DETECTOR" on the 501 front panel.

c. Attenuate the RF to the detector by 40dB. This results in approximately -30dBm to the detector.*

d. Set the LOSS OFFSET dB control to -40.0.

e. Set the SENSITIVITY control to 0.5.

f. Adjust the ZERO dB SET control until the panel meter pointer is centered exactly on "0". Operate the mechanical lock to prevent this control being moved accidentally.

g. Attenuate the RF to the detector by 50 dB. This results in approximately -40dBm to the detector.*

h. Set the LOSS OFFSET dB control to -50.0.

i. With a small screwdriver, adjust the LOW LEVEL tracking until the panel meter is centered exactly on "0".

j. Remove the RF attenuators. This results in the initially set level of approximately +10dBm to the detector.

k. Set the LOSS OFFSET dB control to -00.0.

l. With a small screwdriver, adjust the HIGH LEVEL tracking until the panel meter is centered exactly on "0".

This completes the tracking adjustment. When using a detector for the first time, it is well to go back over the steps to verify correct calibration. No screwdriver adjustment should be necessary if the procedure was carefully followed the first time. If calibration within specifications cannot be obtained, another detector should be tried.

3-3. TYPICAL OPERATIONAL USE FOR LOSS MEASUREMENTS

Filter Response Measurement - A typical test set up for determining the response characteristics of an unknown filter is shown in Figure 3-1.

Notice that an oscilloscope is being used in order that swept frequency results may be rapidly evaluated. Always set the scope vertical sensitivity to 1 volt/cm. This ensures that the calibration of the 501 in dB per cm will be consistent with the display.

A convenient reference line will be displayed during the sweep oscillator retrace time if the blanking output from the sweeper is fed to the 501 back panel BLANKING INPUT. The RETRACE RF switch must be ON.

A typical display might be as shown on page 3-5.

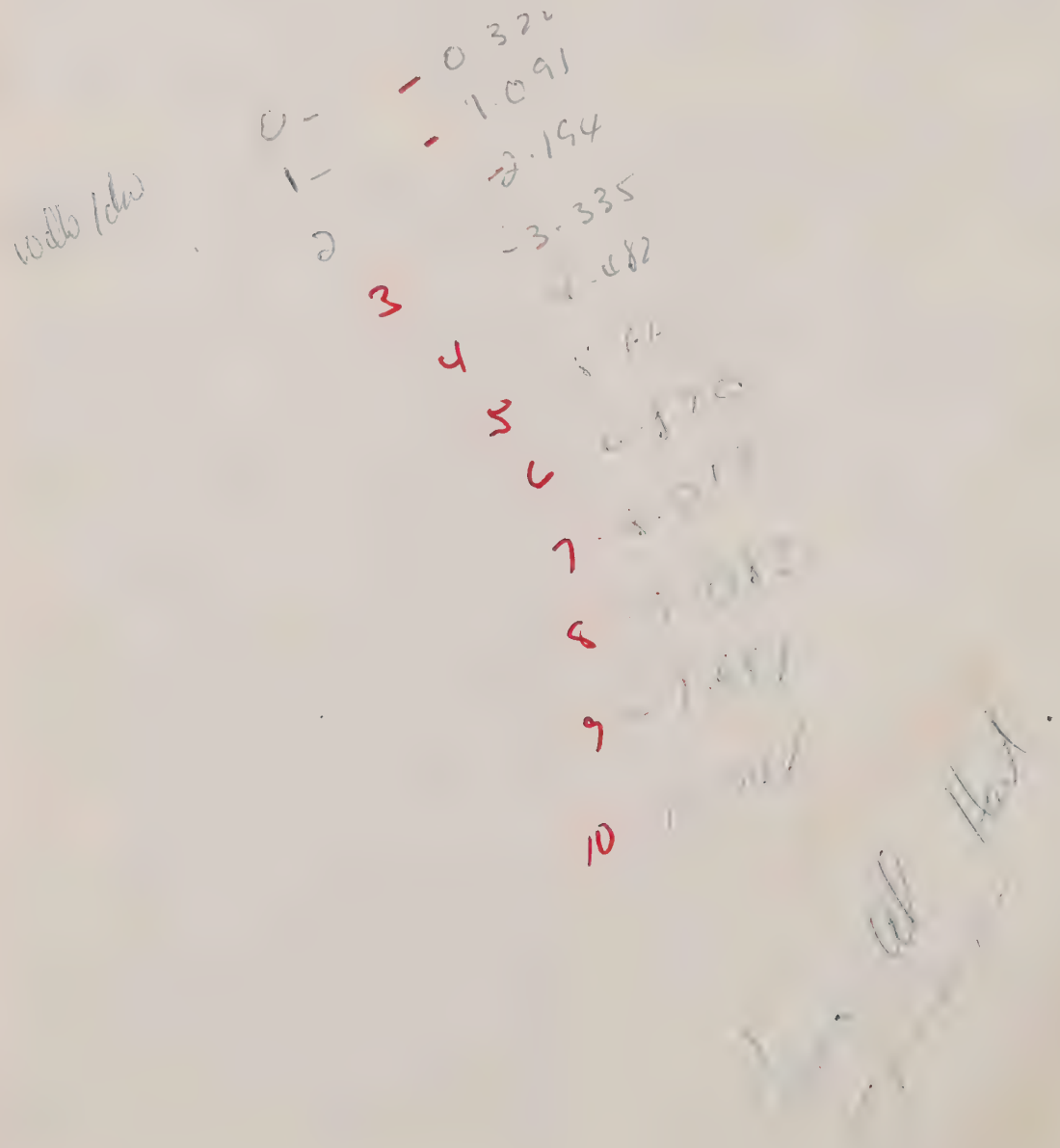
* For test setups using an SWR bridge or autotester, the level to the detector is approx. 12.5 dB less due to the loss across the internal bridge.

NOTE: When using the low level FILTER, the circuit response speed is severly limited. This is a natural consequence of filtering low level noise. Manual sweep or very slow sweep speeds must be used when using the filter.

3-4. GAIN MEASUREMENTS

The gain curve of amplifiers, etc., can be made in a similar manner as for loss measurements. However, the LOSS OFFSET dB polarity should be switched to positive (+), and the scope reference line placed at the bottom of the screen using the ZERO dB SET Control.

If the saturated power output of the RF amplifier being tested excess +20dBm, an attenuator pad should be connected ahead of the r.f. detector.



Do Det. Tracking first pg 3-3

SECTION IV

RECALIBRATION

4-1. PROCEDURE

a. Set the controls as follows:

1. SENSITIVITY to 10dB per division.
2. DETECTOR TRACKING ADJUST, both HIGH LEVEL and LOW LEVEL to approximately mid-range (both are 20 turn screwdriver pots).
3. PANEL METER OFF
4. OFFSET dB to +00.0
5. FILTER OUT
6. POWER ON

b. Connect a high impedance (>1 megohm) voltmeter with 1mV resolution to VIDEO OUTPUT.

c. Adjust ZERO dB SET to obtain 0±10mV on the voltmeter.

d. Set OFFSET dB to +50.0dB.

e. Adjust R194 PLUS OFFSET CALIB to obtain -5.000 ±0.01 volts on the voltmeter.

f. Switch OFFSET dB polarity to -50.0dB.

g. Adjust R147 MINUS OFFSET CALIB to obtain +5.000 ±0.01 volts on the voltmeter.

h. Set OFFSET dB to +30.0 and switch the PANEL METER ON.

i. PANEL METER should deflect 3 Major divisions to the left when OFFSET dB is +30.0 and 3 Major divisions to the right when OFFSET dB is -30.0. Adjust R170 METER CALIB. to minimize error. Should be less than ±1 minor division.

j. Return all controls to the positions as in step a. Connect a -20dBm ±2dBm RF source through a compatible detector having less than 20k ohm video impedance at -30dBm to the INPUT jack.

k. Adjust ZERO dB SET control to obtain 0.000 ±1mV on voltmeter.

l. Insert a calibrated 10dB pad between the RF source and detector. Adjust R159 LOG CALIBRATE to obtain the appropriate dc output (i.e., for a 10.1dB pad the set point is 1.010V ±5mV).

m. Repeat steps k. and l. until the required reading is obtained when the pad is inserted.

n. Insert the calibrated 10dB pad again and note the voltmeter reading.

o. Adjust R131 HIGH LEVEL INTERACT ADJ to minimize the change (<5mV) in the voltmeter reading when the HIGH LEVEL DETECTOR TRACKING ADJUST is exercised through about 5 turns. Note that after making this adjustment the absolute voltmeter reading noted in step n. may be different.

4-2. TROUBLESHOOTING PROCEDURE

The following procedures will allow the service technician to rapidly isolate troubles to a particular circuit section.

a. Set up the Model 501 as shown in Figure 1 and remove the covers.

b. Measure the ±15V dc power supply voltages. Both voltages should be 15V ±0.15V.

c. Monitoring the dc voltage at the outputs of successive stages will show which stage is defective. Set the sweep generator in Figure 1 for a +10 dBm, CW output. (The RF frequency must be within the range of the detector.) Set the Model 501 controls as follows:

LOSS OFFSET dB: 00.0 dB
FILTER IN/OUT switch: OUT
SENSITIVITY: 10 dB per division

d. Refer to Table 1 and measure the voltages listed. These voltages are approximations and will vary depending on the characteristics of the particular Model 501. Any deviation of 0.5 volt or more is suggestive of a problem.

4-3. TRACKING LINEARITY PROBLEMS

If it is impossible to perform the Detector Tracking adjustment procedure (page 3-3) and obtain the required accuracy, be sure that:

a. The RF detector has a video impedance of less than 20k ohms and the sensitivity is adequate (.4mV/mW). It may be necessary to use a different detector.

b. The Model 501 is calibrated.

Table 1. Test Points

Attenuator Position	Output U101	Pin 6 of U104	Pin 6 of U106
0	+1.9V dc	-5.8V dc	0V dc
10	+1.2	-3.8	-1.0
20	+ .5	-1.8	-2.0
30	- .3	≃0	-3.0
40	-1.3	+2.1	-4.0
50	-2.3	+4.0	-5.0
60	-3.3	+5.9	-9.0
	(≃ 1V/10 dB)	(≃ 2V/10 dB)	(≃ 1V/10 dB)

NOTES

1. The "Out of Range" indicator will light when the attenuator is set at 60 dB.
2. Refer to the following troubleshooting chart if improper readings are found.

If Improper Readings are Obtained at	Check or Replace
Output of U101	U101, U102, U103
Output of U104, pin 6	U104, U105, CR110 to CR115
Output of U106, pin 6	U106, CR116, CR117

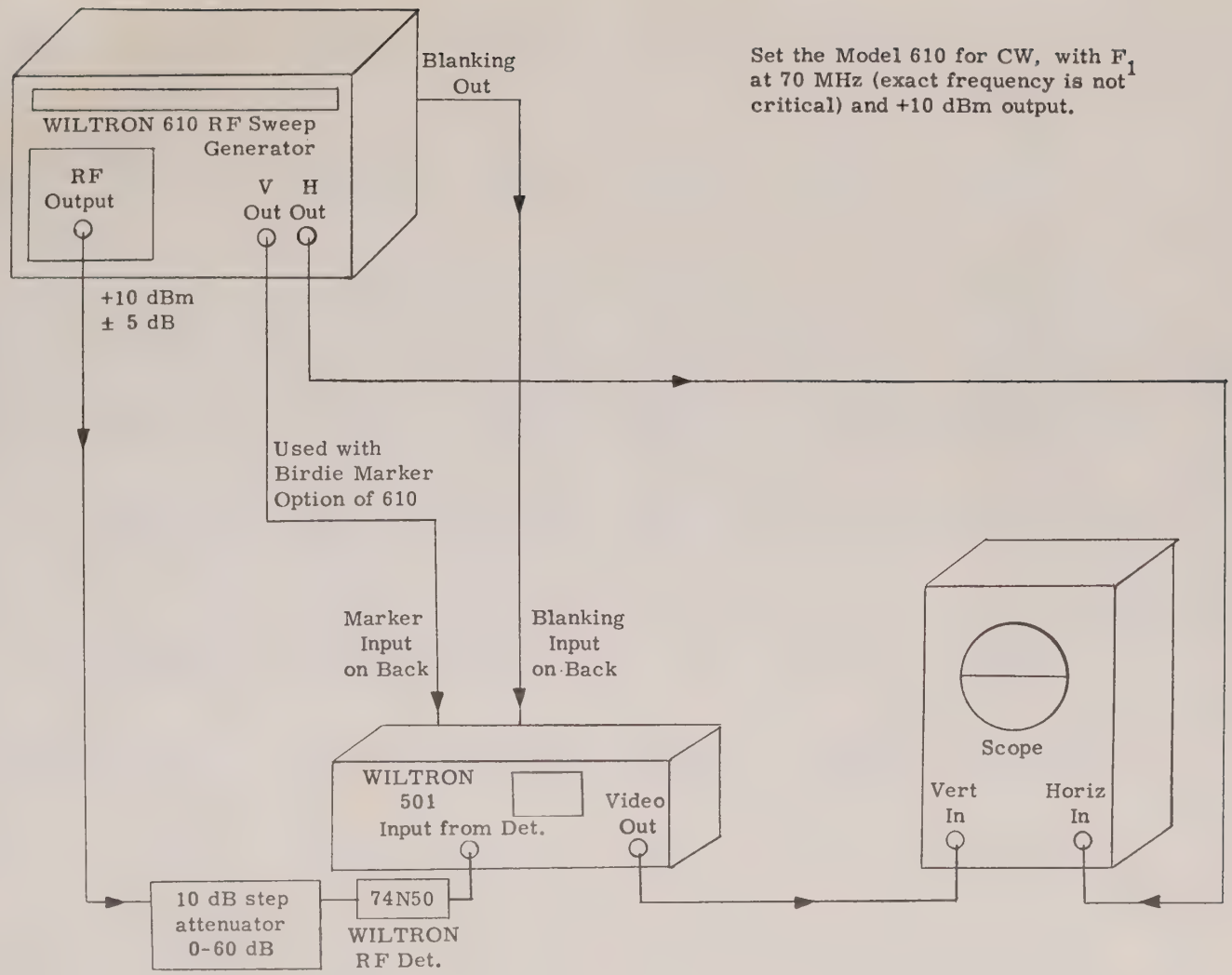


Figure 1. Typical Test Setup

SECTION V

MODEL 501 PARTS LIST

Resistors					Resistors				
R101	12.1k	1/4W	1%	Fixed Film	R137	402	1/8W	1%	Fixed Film
R102	3.83k	1/4W	1%	Fixed Film	R138	21.5k	1/4W	1%	Fixed Film
R103	20k	1/5W	10%	Var Comp	R139	14.7k	1/4W	1%	Fixed Film
R104	3.83k	1/4W	1%	Fixed Film	R140	14.71k	1/4W	1%	Fixed Film
R105	12.1k	1/4W	1%	Fixed Film	R141	42.2k	1/4W	1%	Fixed Film
R106	Not used				R142	46.4k	1/4W	1%	Fixed Film
R107	100k	1/4W	1%	Fixed Film	R143	17.8k	1/4W	1%	Fixed Film
R108	1M	1/4W	1%	Fixed Film	R144	383	1/4W	1%	Fixed Film
R109	19.1	1/4W	1%	Fixed Film	R145	5.11k	1/4W	1%	Fixed Film
R110	1M	1/4W	1%	Fixed Film	R146	909	1/4W	1%	Fixed Film
R111	10k	1/4W	1%	Fixed Film	R147	250	1/4W	20%	Var Comp
R112	1	1/2W	5%	Fixed Comp	R148	2k	2W	.2%	Var Comp S7276-150-7K
R113	14.7k	1/4W	1%	Fixed Film	R149	4.64k	1/4W	1%	Fixed Film
R114	681	1/4W	1%	Fixed Film	R150	1k	1/4W	1%	Fixed Film
R115	10k	1/4W	1%	Fixed Film	R151	383	1/4W	1%	Fixed Film
R116	68.1k	1/4W	1%	Fixed Film	R152	1.5k	1/4W	5%	Fixed Comp
R117	10k	1/4W	1%	Fixed Film	R153	2k	2W	.2%	Var Comp
R118	38.3k	1/4W	1%	Fixed Film	R154	1.5k	1/4W	5%	Fixed Comp
R119	10k	1/4W	1%	Fixed Film	R155	2.37k	1/4W	1%	Fixed Film
R120	3.83k	1/4W	1%	Fixed Film	R156	4.99k	1/4W	1%	Fixed Film
R121	51.1k	1/4W	1%	Fixed Film	R157	42.2k	1/4W	1%	Fixed Film
R122	10k	1/4W	1%	Fixed Film	R158	9.53k	1/4W	1%	Fixed Film
R123	2.15k	1/4W	1%	Fixed Film	R159	1k	1/4W	20%	Var Comp
R124	383	1/4W	1%	Fixed Comp	R160	4.99k	1/8W	1%	Fixed Film
R125	1M	1/4W	1%	Fixed Film	R161	10k	1/8W	1%	Fixed Film
R126	1M	1/4W	1%	Fixed Film	R162	24.9k	1/8W	1%	Fixed Film
R127	13.3k	1/4W	1%	Fixed Film	R163	49.9k	1/8W	1%	Fixed Film
R128	1.47k	1/4W	1%	Fixed Film	R164	100k	1/8W	1%	Fixed Film
R129	464	1/4W	1%	Fixed Film	R165	2.15k	1/4W	1%	Fixed Film
R130	20k	1/4W	10%	Fixed Comp	R166	100k	1/4W	5%	Fixed Comp
R131	10k	1/4W	20%	Var Comp	R167	100k	1/4W	20%	Var Comp
R132	237k	1/4W	1%	Fixed Film	R168	383	1/4W	1%	Fixed Film
R133	26.1k	1/4W	1%	Fixed Film	R169	7.5k	1/4W	1%	Fixed Film
R134	2.74k	1/4W	1%	Fixed Film	R170	5k	1/4W	20%	Fixed Comp
R135	261	1/4W	1%	Fixed Film	R171	100	1/4W	1%	Fixed Film
R136	316	1/4W	1%	Fixed Film	R172	8.25k	1/4W	1%	Fixed Film

R173	46.4k	1/4W	1%	Fixed Film
R174	10k	1/4W	1%	Fixed Film
R175	10k	1/4W	1%	Fixed Film
R176	100	1/4W	1%	Fixed Film
R177	8.25k	1/4W	1%	Fixed Film
R178	46.4k	1/4W	1%	Fixed Film
R179	100k	1/4W	1%	Fixed Film
R180	3.83k	1/4W	1%	Fixed Film
R181	3.83k	1/4W	1%	Fixed Film
R182	10k	1/4W	1%	Fixed Film
R183	100k	1/4W	1%	Fixed Film
R184	4.22k	1/4W	1%	Fixed Film
R185	1M	1/4W	1%	Fixed Film
R186	1M	1/4W	1%	Fixed Film
R187	681	1/4W	1%	Fixed Film
R188	100	1/4W	1%	Fixed Film
R189	Not used			
R190	Not used			
R191	14.7	1/4W	1%	Fixed Film
R192	1.78k	1/4W	1%	Fixed Film
R193	909	1/4W	1%	Fixed Film
R194	250	1/4W	20%	Var Comp
R195	1.47k	1/4W	1%	Fixed Film
R196	82.5k	1/4W	1%	Fixed Film
R197	46.4k	1/4W	1%	Fixed Film
R198	3.16k	1/4W	1%	Fixed Film
R199	2M	1/4W	5%	Fixed Comp
R200	196k	1/4W	1%	Fixed Film
R201	500	Potentiometer		

Capacitors

C101	.001μf	1000V 10%	Fixed Ceram
C102	.05μF	100V +80-20%	Fixed Ceram
C103	Not used		
C104	300pF	500V 5%	Fixed Mica
C105	680pF	500V 5%	Fixed Mica
C106	20pF	500V 5%	Fixed Mica
C107	.002μF	1000V 10%	Fixed Ceram
C108	.002μF	1000V 10%	Fixed Ceram
C109	.05μF	100V +80-20%	Fixed Ceram
C110	.002μF	1000V 10%	Fixed Ceram
C111	.01μF	100V +80-20%	Fixed Ceram
C112	.01μF	100V +80-20%	Fixed Ceram
C113	20pF	500V 5%	Fixed Mica
C114	.002μF	1000V 10%	Fixed Ceram
C115	.05μF	100V +80-20%	Fixed Ceram
C116	.05μF	100V +80-20%	Fixed Ceram
C117	Not used		
C118	Not used		
C119	68pF	500V 5%	Fixed Mica
C120	.01μF	100V +80-20%	Fixed Ceram
C121	10μF	35V 20%	Fixed Tant

Transistors

Q101	2N3565	Q106	2N3638
Q102	2N3638	Q107	2N3565
Q103	2N3638	Q108	2N3565
Q104	2N3638	Q109	KE4393
Q105	2N3638	Q110	KE4393
		Q111	2N3565

Diodes

CR101	1N4446	CR112	1N4446
CR102	1N751A	CR113	1N4446
CR102	1N4446	CR114	1N4446
CR104	1N4446	CR115	1N4446
CR105	HP4403	CR116	1N758A
CR106	1N4446	CR117	1N758A
CR107	1N4446	CR118	1N751A
CR108	1N4446	CR119	1N751A
CR109	1N4446	CR120	1N4446
CR110	1N4446	CR121	1N4446
CR111	1N4446	CR122	1N3491
		CR123	1N3491R

Integrated Circuits

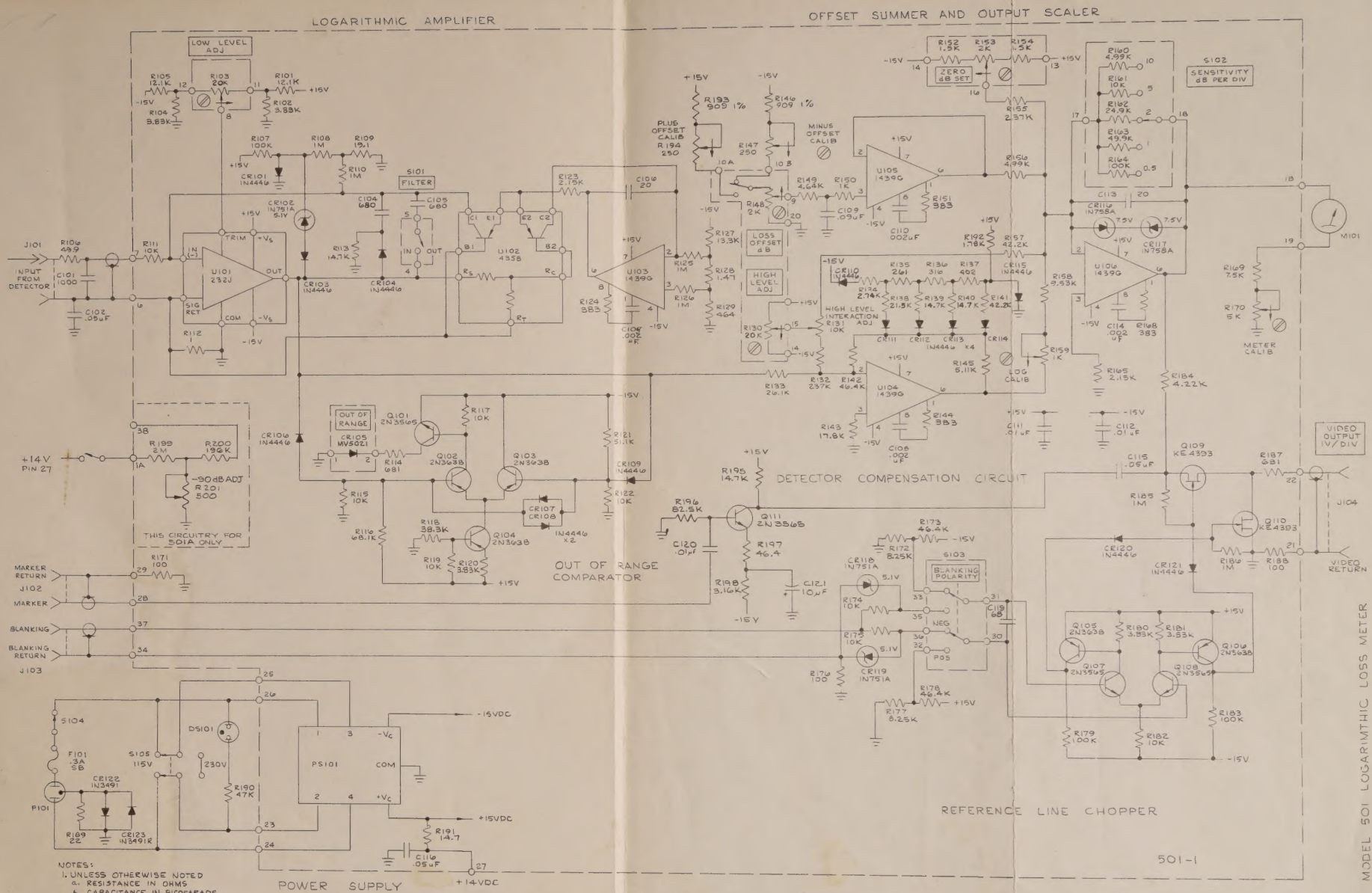
U101	Analog Devices 232J
U102	Philbrick Nexus 4358
U103	MC1439G
U104	MC1439G
U105	MC1439G
U106	MC1439G

Switches

S101	SPDT WILTRON No. 420-5
S102	Rotary WILTRON No. 410-22
S103	DPDT WILTRON No. 430-19
S104	Pushbutton WILTRON No. 430-10
S105	DPDT WILTRON No. 430-9

Miscellaneous

PS1	Philbrick Nexus 2203
DS1	Neon Light Type NE2J
M101	Meter WILTRON No. 600-44


LOGARITHMIC AMPLIFIER
OFFSET SUMMER AND OUTPUT SCALER
DETECTOR COMPENSATION CIRCUIT
OUT OF RANGE COMPARATOR
REFERENCE LINE CHOPPER
POWER SUPPLY
MODEL 501 LOGARITHMIC LOSS METER
501-1
INPUT FROM DETECTOR
+14V PIN 27
THIS CIRCUITRY FOR 501A ONLY
MARKER RETURN
MARKER
BLANKING
BLANKING RETURN
VIDEO OUTPUT 1V/DIV
VIDEO RETURN
METER CALIB
LOG CALIB
ZERO dB SET
SENSITIVITY dB PER DIV
LOW LEVEL ADJ
FILTER
PLUG OFFSET CALIB R 194 250
MINUS OFFSET CALIB
LOSS OFFSET dB
HIGH LEVEL ADJ
HIGH LEVEL INTERACTION ADJ
-90dB ADJ R 201 500
B-BANKING POLARITY
OUT OF RANGE
+15VDC
-15VDC
+14VDC
115V
230V
NOTES:
1. UNLESS OTHERWISE NOTED
a. RESISTANCE IN OHMS
b. CAPACITANCE IN PICOFARADS
2. ALL GROUNDS ON P.C. BOARD ARE NOT CHASSIS GROUND
3. THIS SCHEMATIC APPLIES TO UNITS BEGINNING WITH SERIAL NO 1100B
4. HIGHEST DESIGNATOR ON THIS SCHEMATIC: R 201
C 121
Q 110
1271101
Changed: 1 December 1978
C.O. 1525
PRINT: 12-71
MODEL 501 LOGARITHMIC LOSS METER
501-100
10 - 4 - 71

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